International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD)
ISSN (P): 2249–6866; ISSN (E): 2249–7978
Vol. 12, Issue 1, Jun 2022, 1–10

Original Article

GROUNDWATER QUALITY: WITH FOCUS ON FLUORIDE CONCENTRATION IN KALMALA HOBLI OF RAICHUR DISTRICT, KARNATAKA STATE

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ABSTRACT

In most places of the world, groundwater is the primary source for a variety of functions. Low or excessive concentrations of particular ions are a serious problem because they make groundwater unfit for various uses. Fluoride is one such ion that has been linked to health problems in more than 25 countries around the world. For human consumption, a fluoride concentration of at least 0.6 mg/l is required, as it aids in the development of stronger teeth and bones. Acute to chronic dental fluorosis is caused by drinking water with a fluoride concentration of more than 1.5 mg/l, in which the teeth turn yellow to brown. Long-term ingestion of water containing excessive fluoride causes skeletal fluorosis, which causes bone weakness and bending. Fluoride concentrations in groundwater can be low or high due to natural or manmade causes, or a combination of both. Natural resources are linked to a location's geological conditions. Fluoride-bearing minerals such as apatite, fluorite, biotite, and hornblende can be found in a variety of rocks. The weathering of these rocks, as well as rainfall infiltration through them, raises fluoride levels in ground water. KEYWORDS: Ground Water, Fluoride Concentration, Water Quality Index, Statistical Analysis, Kalmala Hobli of Raichur District & Karnataka

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Received: Oct 21, 2021; **Accepted**: Nov 11, 2021; **Published**: Dec 20, 2021; **Paper Id**.: IJCSEIERDJUN20221

INTRODUCTION

Water is the source of life and serves as the foundation for good health, sanitation, progress, and wealth. As a result, effective water management is critical for civil society to improve its quality of life. It is a basic human requirement as well as the foundation for ecological survival. " There would have been no life without water. It is essential for many elements of economic and social development, including domestic, agricultural, energy generation, industrial supplies, and environmental protection. It is one of the most important items for humans, plants, and other living beings to survive. According to the World Health Organization, water is responsible for around 80% of all human diseases. Stopping the contaminants at the source will not restore the quality of the groundwater once it has been contaminated. As a result, it is critical to assess the quality of groundwater on a regular basis and devise strategies to protect it. One of the most successful tools1-4 for communicating information on water quality to concerned citizens and policymakers is the water quality index. As a result, it becomes a key metric for ground water assessment and management. WQI is a rating that reflects the combined impact of numerous water quality parameters. The WQI is calculated with the goal of determining the suitability of bore well water for human consumption. WQI is an important approach for determining groundwater quality and suitability for drinking. Fluoride in the groundwater comes primarily from fluoride-bearing rocks, which are worn and/or leached out and pollute the water. Fluorides are found in three different forms: fluorospar (CaF2), apatite (Ca3 F) (PO4)3, and

cryolite (Na3AlFg6). Fluoride concentrations are five times higher in granite than in basalt rock locations.

STUDY AREA

As per the Census India 2011, Raichur Taluk has 98,867 house holds, population of 4,98, 637 of which 2,49,556 are males and 2,49,081 are females. The population of children between age 0-6 is 70, 440 which is 14.13% of total population. The sex-ratio of Raichur Taluk is around 998 compared to 973 which is average of Karnataka state. The literacy rate of Raichur Taluk is 55.97% out of which 64.35% males are literate and 47.57% females are literate. The total area of Raichur is 1, 546 sq.km with population densityof323persq.km.

Geography: Kalmala is located at16.19°N77.20°E .It has a naverageelevation of 407 meters (1335ft).

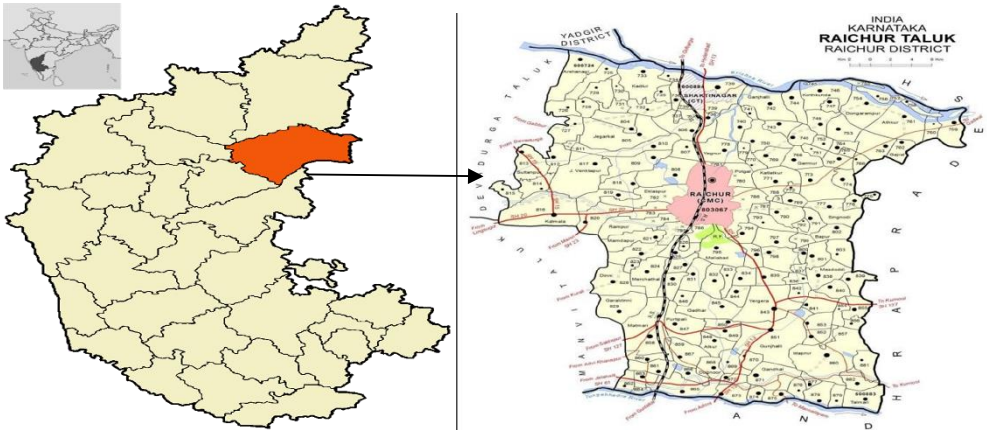

Figure 1

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MATEARIALS AND METHODOLOGY

The samples are collected from 25 different villages. The first and foremost objective of sampling is to collect aportion of the material. Small enough to volume to be transported conveniently and handled in the laboratory while still accurately representing th ematerial being sampled (APHA,1995).In the present investigation, the sample are collectin 20 different village from different localities were collected in clean one litre polythene cans, the cans were then sealed air tight and the area ward numbers are labelled on the cans. Analysis was carried out for fluoride(F')and other physico-chemical parameters such as pH, turbidity, total hardness (TH), total alkalinity (TA),nitrates(NO3), sulphates(S042),phosphates (PO43), chloride (CI-), iron (Fe), according to the procedures outlined in standard methods(APHA,1995).

Data Collection

The bore wells in the study area were selected and GPS is used to locate all the sampling points. The water samples were collected by grab and composite sampling method. Coordinates of sampling stations are tabulated. These sampling stations were among the open wells and borewells.

For the ground water sampling stations shape files are created using ARC GIS10.1.The attribute information was prepared i.e., water quality parameters such as pH, alkalinity, Total hardness, Chloride, Fluoride, Sulphate, and Nitrates and attached to the respective sampling locations. The latitude and longitude were collected by using mobile application Anglecam.2. GPS Map Camera.3.Latitude and Longitude app

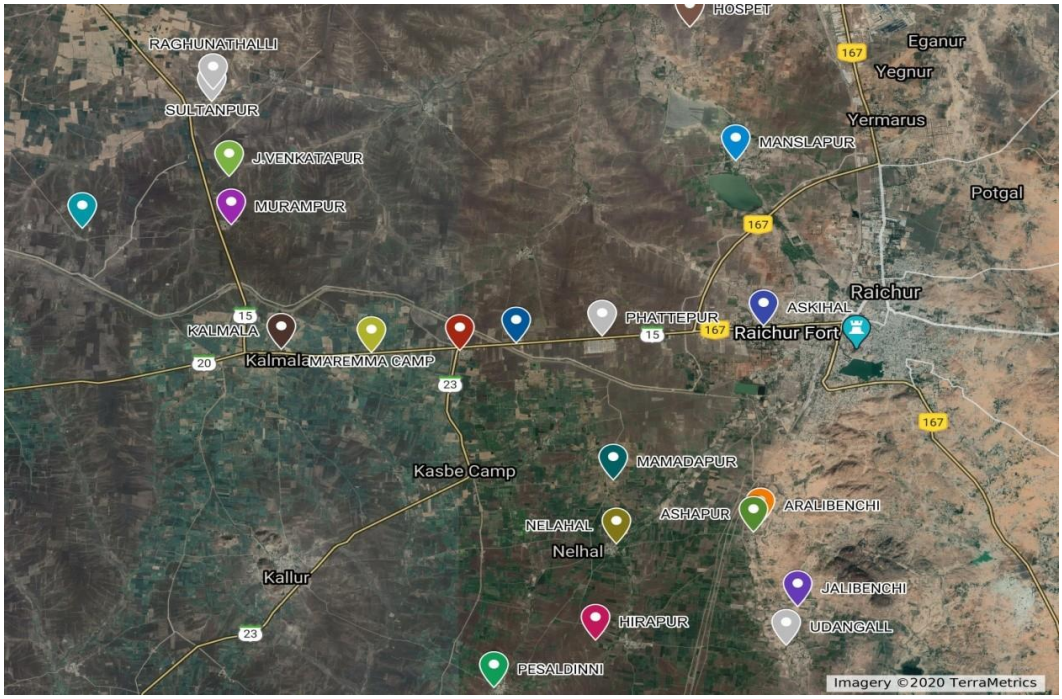


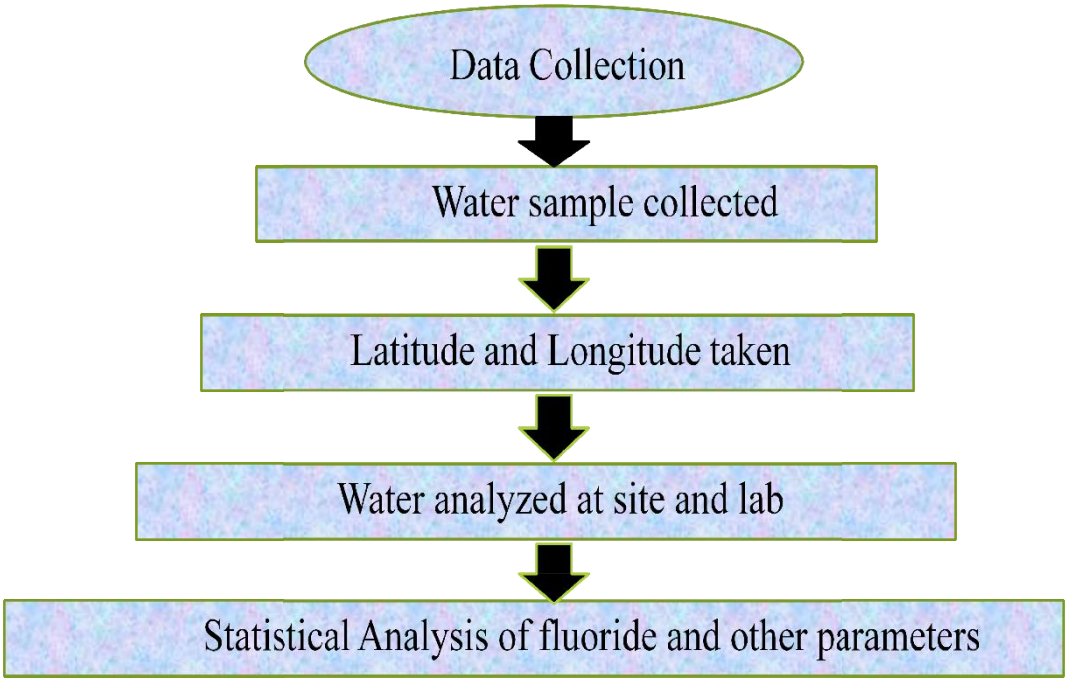
Figure 2:Ground Water Sampling Locations.

Chemical Analysis

Village water samples were gathered in clean plastic bottles. Bottles were completely cleaned with groundwater to be sampled before being collected. Water samples from bore wells were taken after 10 minutes of pumping. pH, alkalinity, chloride, and other parameters Total Hardness, Sulphate, Nitrate and Fluoride were determined using standard proceduresre commended by APHA(1995),BIS(1998)and NEERI(1998).

Estimation of Water Quality Index

The Water Quality Index (WQI) is a very helpful and effective approach for monitoring water quality as well as a tool for expressing information about water quality in general. The Water Quality Index (WQI) provides for the quantification of 'good' and 'poor' water quality by reducing a significant amount of data on a variety of physical, chemical, and biological variables to a single number in a straightforward, objective, and repeatable manner. WQI helps people comprehend water quality issues by combining complex data and giving a score that summarises water quality state and analyses trends. The WQI was determined in this study using the weighted index approach and drinking water quality criteria suggested by the Bureau of Indian Standards (BIS) and the Indian Council for Medical Research (ICMR). The Weighted Arithmetic Index method is used to construct the Water Quality Index (WQI). A water quality index based on a few key parameters can provide a quick assessment of water quality. It provides an overview of the potential issues with the water accessible and consumed in the region. Water quality and suitability for drinking can be determined by calculating the water quality index for the average person.



FOLLOWING ARE STEPS IN VOLVED:

RESULTS AND DISCUSSIONS

Water is one of the most important elements for the survival of life on the planet. Unfortunately, human activities are polluting water resources these days, and they are becoming unfit for usage sooner than predicted. The presence of numerous harmful compounds in water bodies is hazardous to one's health. Groundwater is regarded to be the safest water for drinking and household use among the numerous sources of water. The concentration and distribution of key ions in groundwater are frequently studied during a hydro-geochemical examination of any groundwater system. When consumed in a controlled dose of less than 1 ppm, fluoride, an element found in groundwater, has a favourable effect on the human body, preventing dental cavities. Nonetheless, when present in concentrations surpassing 1 ppm and 5 ppm, larger concentrations induce significant dental and skeletal fluorosis. The fluoride content and other physicochemical characteristics of Raichur Taluka have been provided in this study. The BIS and WHO standard values for several physico-chemical parameters for drinking water.

Analytical data of the chemical analyses of ground water in study area during post monsoonse as on (inmg/l).

Table1: Comparison of Ground Water Quality with Drinking Water Standards, Indian and WHO.

S.No	pH	NO2	NH4	F	PO4	Cl	TH	FE-
1	8.3	20	0.5	2.22	0	1600	750	0.3
2	8.5	20	0.8	2.1	0.3	1500	1750	0.3
3	8.2	50	0.4	1.94	0.5	390	1250	0.3
4	8.2	50	0.7	1.87	0.3	385	260	1
5	7.5	30	0.3	2	0.2	660	900	1
6	8.5	30	0.3	1.95	0.5	500	450	0
7	8	50	0.1	2.81	0.5	450	550	3
8	8.3	30	0.8	2.8	0.1	430	3750	3
9	8	5	0.1	1.81	0.1	500	200	0.1
10	8.5	20	2.2	1.8	0.2	520	350	0.3
11	8	50	0.3	2.87	0.2	150	150	0

12	6.8	10	0.5	2.85	0.2	130	350	0
13	8.3	50	0.4	1.86	0.3	100	1100	3
14	8.2	40	0.3	1.82	0.2	90	1000	5
15	8.5	5	0.1	1.93	0.1	75	350	0
16	8.2	10	0.2	1.92	0.2	80	300	0
17	8	20	0.4	0.78	0	75	900	5
18	7	20	0.3	0.75	0	75	700	4
19	8.5	30	1.5	0.83	0	50	500	0
20	8.5	25	1.2	0.87	0.2	45	400	3
21	6.5	5	0.1	2.57	0.1	170	350	0.1
22	8.3	50	0.2	2.5	0	180	500	0.3
23	8.5	5	0.1	2.6	0	120	250	0
24	8.2	10	0.2	2.7	0.1	120	230	0.2
25	8	20	0.4	1.47	0.2	160	400	0
26	7	15	0.3	1.45	0.3	150	300	0.1
27	8	50	0.4	2.67	0	150	175	1
28	7	40	0.3	2.65	0.2	140	150	0.3
29	8	50	0.4	2.26	0.4	120	650	0.3
30	7.5	45	0.3	2.25	0.3	110	600	0.2
31	8	50	0.5	0.5	0.5	100	250	0.4
32	7	40	0.3	0.8	0.4	90	260	0.3
33	9	5	0.5	1.5	0.6	140	450	0
34	7.5	5	0.4	1.8	0.5	130	450	0.2
35	7	50	0.5	1.9	0.7	170	350	0
36	7.5	45	0.3	1.5	0.5	150	320	0.1
37	7	30	0.3	2.1	0.2	190	400	0
38	8	20	0.2	2.3	0.5	180	380	0.1
39	7	80	0.5	1.56	0.3	250	300	0
40	8.5	20	0.4	1.8	0.3	220	280	0.2
41	7	50	0.5	1.9	0.3	180	400	0
42	7.5	90	0.4	1.8	0.2	170	350	0.1
43	9.7	0	0.5	1	0.2	490	450	0.2
44	9.5	0.1	0.7	1.2	0.4	500	480	0.3
45	8.5	85	0.3	1.7	0.3	150	340	0.2
46	9	80	0.2	1.8	0.5	140	350	0.3
47	8	85	0.4	1.7	0.5	150	300	0.2
48	8.5	90	0.3	1.5	0.6	140	290	0.3
49	9	85	0.2	1.9	0.7	130	300	0.5
50	8.4	120	0.4	1.8	0.55	140	290	0.4

Table 2: Normal Statistics of Water Quality Parameters of Ground Water Samples

Parameters	Indian Standard	Percent compliance	WHO Standard	Percent compliance
pH	6.5-8.5	98.5	7.0-8.0	91
Electrical conductivity	-	-	-	-
Total dissolved solids	500	70	1,000	96.5
Total hardness as $CaCO_3$, mg/L	300	70	100	0.5
Carbonate, mg/L	-	-	-	-
Bicarbonate, mg/L	-	-	-	-
Chloride, mg/L	250	97	250	97
Sulphate, mg/L	200	100	250	100
Phosphate, mg/L	-	-	-	-
Nitrate, mg/L	45	51.5	50	56.5
Fluoride, mg/L	1	30	1	30
Calcium, mg/L	75	96	75	96
Magnesium, mg/L	30	26	30	26
Sodium, mg/L	-	-	200	-
Potassium, mg/L	-	-	-	-
Iron, mg/L	0.3	0.5	0.1	0.5
Manganese, mg/L	0.1	17	0.05	17

Table 3: Relative Weight of Chemical Parameters

Parameters	Min	Max	Mean	Median	Std Deviation
pH	6.5	9.7	8.072	8.2	0.646
NO_3^-	0	120	37.702	30	28.34
NH_4^+	0.1	2.2	0.438	0.4	0.362
F^-	0.5	2.87	1.8592	1.865	0.598
PO^-t_4	0	0.7	0.289	0.3	0.197
Cl^-	45	1600	260.7	150	304.896
TH	150	3750	531.1	350	554.706
Fe2+	0	5	0.712	0.2	1.29

Except for pH, all units are in mg/l, with Min-Minimum, Max-Maximum, Median, and SD-Standard Deviation. AM stands for arithmetic mean. There are three steps to calculating WQI. In the first phase, each of the 19 characteristics was given a weight (wi) based on its relative value in determining the overall quality of drinking water (Table 3). Because of its relevance in determining water quality, the parameter nitrate has been given a maximum weight of 5. Magnesium, which is given a minimum weight of 1, may not be detrimental on its own. Other the relative weight (Wi) is calculated in the second step using the following equation:

$$Wi = wi/\sum wi \quad (1)$$

Where Wi denotes relative weight, wide notes parameter weight, and n is the number of parameters. Table 3 also includes the calculated relative weight (Wi) values for each parameter. In the third phase, each parameter is assigned a quality rating scale (qi) by dividing its concentration in each water sample by its respective standard according to the BIS rules and multiplying the result by 100.

$$qi=(Ci/Si)\ x100 \quad (2)$$

Table 4: Water Quality Classification based on WQI Value

Chemical Parameters	Indian Standards	Weight(wi)	Relative Weight(Wi)
pH	6.5-8.5	5	0.192
NO3	45-100	5	0.192
NH4	1.5	3	0.115
F	1-1.5	2	0.077
PO4	200	2	0.077
Cl	250-1000	3	0.115
TH	300-600	2	0.077
Fe	0.3-1.0	4	0.153
		$\sum wi=26$	

Where qi denotes the quality rating, Ci denotes the concentration of each chemical parameter in each water sample in milligrammes per litre, and Si denotes the Indian drinking water standard for each chemical parameter in milligrammes per litre, as defined by the BIS7 10500, 1991 recommendations.

To calculate the WQI, first find the SI for each chemical parameter, which is then utilised to calculate the WQI using the equation below.

$$SIi=Wi.qi \quad (3)$$

$$WQI=\sum SIi \quad (4)$$

SIi is the ith parameter's subindex; qi is the rating based on ith parameter's concentration; and n is the number of parameters. The computed WQI values are divided into five categories, ranging from "good water" to "water unfit for drinking."

WQI Value	Water Quality	Percentage of Water Samples(Post-Monsoon)
<50	excellent	16
50-100	Good water	68
100-200	Poor water	16
200-300	Very poor water	nill
>300	Water unsuitable for drinking	nill

Correlation of Fluoride with other Parameters

Correlation is useful to find the relation among the fluoride and other various parameter. The concentration of fluoride showed positive correlation with pH, total alkalinity, chloride, nitrate, iron and showed negative significant correlation with total hardness, phosphate. The coefficient correlation always measures the relationship between the dependent and independent variables. The coefficient correlation is+1or-1, shows the perfect linear relationship between variables.

Correlation matrix fluoride in other physico-chemical parameter of all study sites during post monsoon season.

Parameters	pH	NO_3^-	NH_4^+	F^-	PO^{-3}_4	Cl^-	TH	Fe2+
pH	1							
NO_3^-	-0.0148	1						
NH_4^+	0.210408	-0.09771	1					
F^-	-0.16257	-0.00573	-0.27684	1				
PO^{-3}_4	0.114416	0.4365	-0.11726	-0.13948	1			
Cl^-	0.208434	-0.19331	0.195155	0.154668	-0.11062	1		
TH	0.114188	-0.09546	0.176369	0.158109	-0.14641	0.344495	1	
Fe2+	0.024776	-0.02828	0.043588	-0.17985	-0.24593	-0.08939	0.434838	1

Fluoride and other Physico-Chemical Parameters

Fluoride(F")The presence of fluoride(F")in drinking water is essential because of its physiological effects on human health.1.5 ppm fluoride is prescribed as desirable limit in drinking water (WHO, 1984).The natural occurrence of fluoride is generally limited as most waters have a concentration less than 0.5 ppm (Renn, 1970) and high fluoride concentration in ground water can be due to the presence of fluoride-bearing rocks and the degree of eathering (Srinivasetal, 2000).Fluoride is often referred to as two edged word. Fluoride with 0.6 to 1.2 ppm is regarded as an essential constituent of drinking water mainly because of its role inprevention of dental caries (McClure, 1970) whereas concentrations more than 1.5 ppm leads to dental and skeletal fluorosis (Prajapati and Rao, 2004).When the concentration of fluoride in water exceeds 10 ppm, crippling fluorosis can ensure (WHO, 1984). In the present investigation, fluoride values varied from a minimum of

0.54mg/l to a maximum of 2.3mg/1with a mean value of 1.091mg/1 In post monsoon season..

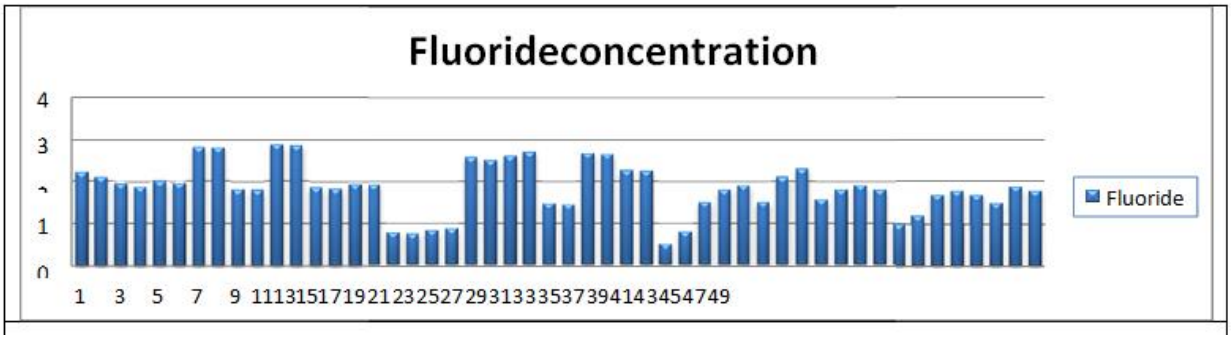


Figure 3: Fluoride Concentrationing Round Water of Kalmala Hobli of Raichur District, Karnataka.

CONCLUSIONS

Ground water is contaminated by various elements in which fluoride is one of the important elements. Today, it is important to know the concentration of fluoride present in ground water. Fluoride is necessary in drinking water with in a concentration of 0 to1.5mg/1. If the concentration exceeds 1.5mg/1(the permissible limit) for many years it may cause dental fluorosis, skeletal fluorosis in human and can cause teeth and bone disease in horses and cattle. Fluoride consumption in convenient amounts in the water supply imparts protection against the development of dental caries without staining the teeth. In the present investigation, an attempt has been made to understand the concentration of fluoride and major physicochemical parameters in the ground water of Raichur Taluk. The observed values of fluoride concentration has shown that some of sample having more than the permissible limits according to the (BIS, 1998), (WHO, 1984) and (IS10500:2012)drinking water standards.

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